NON-PUBLIC?: N
ACCESSION #: 8807210219
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Waterford Steam Electric Station Unit 3 PAGE: 1 of 7

DOCKET NUMBER: 05000382

TITLE: Reactor Trip Due to Turbine Control System Failure and Procedural Inadequacy
EVENT DATE: 06/14/88 LER #: 88-016-00 REPORT DATE: 07/14/88

OPERATING MODE: 1 POWER LEVEL: 012

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: R.S. Starkey, Operations Superintendent
TELEPHONE #: 504-464-3178

COMPONENT FAILURE DESCRIPTION:
CAUSE: B SYSTEM: JJ COMPONENT: DCC MANUFACTURER: W120
REPORTABLE TO NPRDS: N
CAUSE: B SYSTEM: KA COMPONENT: 33 MANUFACTURER: P358
REPORTABLE TO NPRDS: N

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT: At 2246 hours on June 14, 1988, Waterford Steam Electric Station Unit 3 was operating at approximately 12% power when the Reactor tripped due to low Steam Generator (SG) water level. Prior to the trip, Turbine Generator (TG) control had been transferred from Throttle to Governor Valves when an Overspeed Protection Control (OPC) signal caused the Governor and Intercepter valves to close. The TG stabilized at 1800 rpm. The OPC Test Switch was then placed in test to reseat an OPC solenoid valve which was believed to be stuck open. When the switch was returned to normal, TG Governor Valves reopened, causing a sudden increase in steam demand resulting in a large swell in SG levels. The rise in SG Downcomer Level caused the Feedwater Isolation Valves to shut, tripping Main Feed Pump "A". SG levels subsequently lowered to the low level trip setpoint as feed was being restored. SG levels were restored and the plant was stabilized in hot standby.

The root cause of the event was equipment malfunction. A circuit card for

Governor Valve Number Two failed causing the valve to remain at least 25% open. The circuit card was replaced. The cause of the MFP trip is under investigation. Procedures are being revised to include precautions for OPC testing. Since all safety systems functioned as designed, there was no safety significance to this event.

(End of Abstract)

On June 14, 1988, Operations personnel were conducting a plant startup at the Waterford Steam Electric Station Unit 3. The plant was operating at 17% power with the Main Turbine Generator (TG) (EIIS Identifier TA) rolling unloaded at 1700 rpm when control was transferred from the Throttle Valves (TV) (EIIS Identifier SB-FCV) to the Governor Valves (GV) (EIIS Identifier SB-FCV) in accordance with operating procedure OP-5-007, "Main Turbine Generator". The TG is normally started in TV control mode, in which the GVs are full open and TVs control TG speed. In normal operation the TVs are fully open and the GVs throttle steam flow to the High Pressure Turbine. The TG control system is programmed to automatically tr
nsfer
between control modes while maintaining control of TG speed. During the transfer, TG speed increased, actuating an Overspeed Protection Control (OPC) signal. The OPC signal causes the GVs and Interceptor Valves (IV) (EIIS Identifier SB-ISV) to close if TG speed reaches 103% of the rated speed of 1800 rpm. GVs and IVs will reopen when the referenced speed is re-attained. TVs and GVs control steam flow to the HP Turbine (EIIS Identifier TA-TRB), and Reheat Stop Valves (RSV) (EIIS Identifier SB-ISV) and IVs isolate steam flow to the Low Pressure (LP) Turbine (EIIS Identifier TA-TRB). This OPC actuation may have been caused by an intermittent failure in the Digital Electrohydraulic (DEH) Control System (EIIS Identifier JJ) circuit card which caused one GV to remain at least 25% open. The DEH System controls GV position to control turbine speed with all TVs open when in GV control mode.

The OPC signal cleared and the TG stabilized in Governor Valve Control at 1800 rpm. Operations personnel noticed Electro-Hydraulic (EH) System (EIIS Identifier TG) fluid pressure was drifting down, and this could only be stopped by starting the standby EH Pump (EIIS Identifier TG-P). EH fluid is used by the DEH Control System to open TVs, GVs, IVs and RSVs. The valves are closed by springs. Since no TG speed control problems were now observed, investigation focused on the EH pressure rather than the cause of the OPC actuation. There is normally very little flow in the EH System unless valves are being moved, and the indications observed showed a

relatively large flow rate to the valves and back to the EH reservoir. Since an OPC signal had been actuated, an OPC Solenoid Valve (EIIS Identifier TG-SSV) was most likely stuck partially open, causing the low EH System pressure. The two OPC Solenoid Valves dump EH fluid supply pressure to the GVs and IVs which will cause the valves to shut.

After a walkdown of these systems, the TG Vendor Representative recommended that Operations personnel perform an OPC Test in order to cycle and reseat the OPC Solenoid Valves. With the TG rolling at 1800 rpm, Operations personnel placed the OPC Test Keyswitch (EIIS Identifier JJ-HS) in OPC Test. The OPC Test Switch was held in OPC Test for approximately one minute. When the switch was returned to the In-Service position, the IVs opened and the GVs began to stroke open. The OPC Test had closed these valves, causing the TG to coast down. The DEH Computer does not receive any input from the OPC test circuitry, and the DEH System was set to control TG speed at 1800 rpm, so the DEH Computer sensed the lowering rpm while the OPC test switch was held and signaled the GVs to open. This opening signal was defeated by the OPC signal until the OPC Test Switch was returned to normal, at which point all four GVs began to stroke open. As the GVs opened, steam flow spiked to approximately 80%. TG speed increased, and the TG was manually tripped at 1846 rpm. OPC tests previously performed at 1800 rpm have not shown a significant change in steam flow, so this transient was not anticipated. In previous OPC Tests conducted at 1800 rpm, however, the OPC keyswitch was held in the OPC Test for no more than a few seconds.

The sudden steam demand caused swell in the SGs which forced SG Downcomer Water Level to rise quickly, causing a SG High Level Trip to be received on channel B of the SG Narrow Range Level Instrument (EIIS Identifier JC-LI). The trip logic requires two out of four coincidence, so the Reactor (EIIS Identifier RCT) did not trip due to SG high level. The rapid rise in level caused the SG Wide Range Level Instrument (EIIS Identifier JC-LI) to shut both Main Feedwater Isolation Valves (MFIVs) (EIIS Identifier SJ-ISV). MFIVs are designed to close at 96% wide range level indication, and the Reactor trip setpoint is 87.7% narrow range level indication. The narrow range high level trip is set at an actual SG level lower than the SG level used to shut the MFIVs. The narrow and wide range instrument reference leg taps are the same height, but the wide range variable leg tap is lower than the narrow range variable leg tap. Thus the rapid rise in downcomer level had a greater effect on the wide range SG level instrument due to the flow-induced pressure variations, causing the MFIVs to shut prior to the actuation of a narrow range high level channel trip. Since in this case the pressure drop tended to induce a higher indication in both level instruments, there is a high level of confidence that actual level remained

below the trip setpoint.

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Shortly after the MFIVs shut, Main Feed Pump (MFP) (EIIS Identifier SJ-P) "A" tripped due to low flow. Operators opened the MFIVs to restore feedwater flow and commenced boration and shimming in of Regulating Group Control Element Assemblies (CEAs) (EIIS Identifier AB-ROD) to reduce Reactor power and steam demand. The Auxiliary Feed Pump (AFP) (EIIS Identifier SJ-P) was started after approximately a one minute delay to manually reset the Hotwell Transfer Pump Bypass Valve Open Limit Switch (EIIS Identifier KA-33). The AFP supplies approximately 7% feedwater flow. MFP "A" was restarted, but tripped as discharge pressure was being raised. The reactor was at approximately 12% power as MFP "A" was again restarted and discharge pressure was being raised when SG Levels dropped to the low level trip setpoint. At 2246 hours on June 14, 1988, the Reactor tripped due to low level in SG Number One. Low level trips were subsequently received on all four trip channels for both SGs. Emergency Feedwater Actuation Signal (EFAS) channels one and two actuated, and all Emergency Feedwater Pumps (EFW) (EIIS Identifier BA-P) started automatically, but SG levels did not drop low enough for the pumps to inject EFW to the SGs. SG Levels were restored using MFP "A" and the AFP. Operations personnel performed OP-902-000, "Emergency Entry Procedure," and OP-902-001, "Uncomplicated Reactor Trip Recovery Procedure," and the plant was stabilized in hot standby (Mode 3).

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The initial evaluation of the Reactor trip by Operations personnel concluded the cause of the sudden steam demand and subsequent reactor trip was due to procedural inadequacy since OP-5-007 did not specify a time limit for holding the OPC keyswitch in OPC Test. Procedure OP-5-007 will be changed to include a caution statement recommending that the OPC Test be performed prior to rolling the TG with Main Steam (EIIS Identifier SB). MFIVs are provided with two hydraulic accumulators, either of which is capable of shutting the valve within five seconds at full flow. Since both actuators functioned in this case and feedwater flow was relatively low the MFIVs would have shut in approximately two seconds and would only have affected feed flow in the last 30% of their stroke, when the valve is moving at maximum velocity. The cause of the loss of the MFP was attributed to this sudden loss of flow transient for which, it was believed at the time, the MFP was not designed to handle. After these concerns had been addressed, preparations were made to restart the plant.

At approximately 0830 hours on June 15, 1988, Operations personnel were performing a plant startup when an OPC occurred as TG control was transferred from TVs to GVs. The TG was immediately tripped. When it was subsequently

relatched, GV 2 was noted to indicate intermediate rather than closed as it should have. Investigation by Maintenance personnel discovered an intermittent fault on a Digital to Analog Converter (XHC) Circuit Card (EIIS Identifier JJ-DCC) which would add 25% to the demand signal to GV Number Two. Thus, the OPC actuation occurred when TVs opened to transfer control and GV Number Two stayed open too wide to control the TG speed. It was then realized that this was also the likely cause of the previous OPC actuation which initiated the sequence of events leading to the Reactor trip. An evaluation of the failed XHC card discovered a failed Integrated Circuit (IC) Chip (Westinghouse Part Number 4930A62H01) which intermittently caused the card output to prevent GV Number Two from shutting to less than 25% open. The failed XHC card was replaced.

Prior to the low SG level trip, the operating MFP tripped on low suction flow shortly after the MFIVs closed. The MFP Recirculation Valve (EIIS Identifier SJ-FCV) FW 111A, is designed to maintain a minimum flow of 2700 gallons per minute (gpm) through the MFP to prevent a low flow trip. At the time of the trip, this valve controller was in manual and approximately 80% open to prevent the valve from hunting, which frequently occurs at low flow rates. No definite cause or sequence of events has been identified to explain this MFP trip. An evaluation has been initiated to determine whether or not the MFP should have tripped during the transient, and if not, the exact cause of the MFP trip.

The root cause of this event was equipment malfunction due to the failed XHC card which caused the OPC actuation. Procedural inadequacy then resulted in maintaining the OPC keyswitch in OPC Test long enough to generate a large open signal to the GVs. The resulting transient caused a loss of feedwater which was aggravated by equipment problems with the MFP and AFP, and these equipment problems resulted in the SG low levels and reactor trip. The MFP and AFP were operating at the time of the trip and were used to restore SG levels to normal. All three Emergency Feedwater Pumps were operable but were not required to inject water into the SGs. There was, therefore, always adequate decay heat removal capability available. Since all safety systems functioned as designed, this event did not pose a threat to the health and safety of the public or plant personnel.

SIMILAR EVENTS

Reactor trips due to low SG water level at low power were reported in LERs 85-10, 85-13, 85-14, 85-20.

PLANT CONTACT

R.S. Starkey, Operations Superintendent, 504/464-3178.

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Ref: 10CFR50.73(a)(2)(iv)

LOUISIANA
POWER & LIGHT WATERFORD 3 SES P.O. BOX B KILLONA, LA 70066-0751
MIDDLE SOUTH
UTILITIES SYSTEM

July 14, 1988

W3A88-0078
A4.05
QA

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, D.C. 20555

SUBJECT: Waterford 3 SES
Docket No. 50-382
License No. NPF-38
Reporting of Licensee Event Report

Attached is Licensee Event Report Number LER-88-016-00 for Waterford Steam Electric Station Unit 3. This Licensee Event Report is submitted pursuant to 10CFR50.73(a)(2)(iv).

Very truly yours,
/s/ N.S. Carns
N.S. Carns
Plant Manager - Nuclear

NSC/WEM:rk
Attachment
cc: R.D. Martin, NRC Resident Inspectors Office, INPO Records Center
(J.T. Wheelock), E.L. Blake, W.M. Stevenson, D.L. Wigginton

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